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Lucien Zalcman

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Lucien Zalcman

Air Operations Division
Systems Sciences Laboratory

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ABSTRACT

The recent I/ITSEC 2001 Coalition Training Demonstration held between the US, Australian and Dutch Navies demonstrated a valid coalition training exercise using Advanced Distributed Simulation to simultaneously connect military training simulators in the USA, Australia and the Netherlands. Whilst participating in the setting up and running of this exercise each participating nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such a coalition exercise, this paper discusses a proposal to make available to all participating coalition nations a Common Coalition Toolset (CCT) which comprises a set of software applications used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes some of the software applications making up this Common Coalition Toolset and what operating systems / programming toolkits etc. should be considered when creating such Common Coalition Toolset applications.

RELEASE LIMITATION

Approved for public release

A Common Coalition Toolset

Executive Summary

In December, 2001 a valid Coalition Training Exercise was held between RAN training simulators at HMAS Watson in Sydney, US Navy simulators at Dam Neck, Virginia and the I/ITSEC 2001 conference in Orlando, Florida and simulators at the TNO Laboratories in the Netherlands using Advanced Distributed Simulation.

Whilst participating in the setting up and running of this exercise each participating nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such a coalition exercise, this report discusses a proposal to make available to all participating coalition nations a Common Coalition Toolset (CCT) which comprises a set of software applications used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes some of these software applications already used in the Air Operations Division's Advanced Distributed Simulation Laboratory. In addition to these Distributed Simulation applications, operating systems and programming toolkits are also discussed and recommended.

Having such a Common Coalition Toolset, which all participating nations have access to, allows such demonstrations and exercises to be more effectively and efficiently set up, maintained and monitored.

The operating systems, programming languages, distributed simulation toolkits and CCT applications discussed and recommended are not meant to be a definitive toolset. The objective of this paper is to start the discussion of the concept of a Common Coalition Toolset.

Authors

Dr Lucien Zalcman
Air Operations Division

Dr Lucien Zalcman graduated from Melbourne University with a BSc (Hons.) in 1973. He was awarded a PhD in Physics from Melbourne University in 1980. He also completed a Graduate Diploma in Computing Studies at RMIT graduating in 1987. During the period 1980 - 1984 he worked as an Experimental Officer at the CSIRO Division of Mineral Chemistry carrying out research into lead acid batteries for electric vehicles. He joined DSTO in 1984 as an Information Technology Officer in the Computer Centre at the Aeronautical Research Laboratory. In 1992 he was employed as a Senior Professional Officer in Air Operations Division of AMRL specialising in the field of Distributed Interactive Simulation. He was promoted to Senior Research Scientist in 1998.

Contents

1. Introduction

The Australian Defence Force (ADF) is adopting Advanced Distributed Simulation (ADS) technologies such as Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) to enhance its training capability. To support this thrust, Air Operations Division (AOD) of the Defence Science and Technology Organisation (DSTO) has developed the Advanced Distributed Simulation Laboratory (ADSL) which promotes the use of modular, cost-effective, Commercial-Off-the-Shelf (COTS) ADS applications running on low cost computing platforms. The use of COTS software and hardware should lower purchase, development and maintenance costs and increase the probability that project functionality is delivered on time. It is a risk reduction strategy.

On behalf of the Australian Navy, DSTO recently signed a Project Arrangement (PA) with the US Navy (PMS 430 [1]) to advance coalition training using Advanced Distributed Simulation. As part of this Project Arrangement, DSTO and the Australian Navy participated in an Interservice / Industry Training Simulation & Education Conference (I/ITSEC) 2001 Coalition Training Demonstration held between the US, Australian and Dutch Navies which demonstrated a coalition training exercise using Advanced Distributed Simulation to simultaneously connect military training simulators in the USA, Australia and the Netherlands. Whilst participating in the setting up and running of this coalition training exercise, each participating nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such an exercise, this paper puts forward a proposal to develop a Common Coalition Toolset (CCT) which comprises a set of software recommendations and applications that can be used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes some of the software applications making up this Common Coalition Toolset and what operating systems / programming toolkits etc. should be considered when creating such applications.

Applications developed and used in the AOD ADSL [2, 3] (which were used to establish and maintain connectivity and interoperability at the Australian end of the I/ITSEC 2001 demonstration) form the basis of the Australian contribution to the Common Coalition Toolset proposed in this paper.

2. Computer Technology Trends

2.1 Hardware

In today's environment, the use of COTS software and hardware reduces considerably the cost of purchase and development of Advanced Distributed Simulation

applications. Maintenance costs are also reduced as this responsibility is shifted to the COTS developer.

PC processor speeds continue to increase with Intel and AMD 32-bit processors with clock speeds in excess of 2GHz now released. Software compatible Intel 64-bit Itanium systems are also available. The cost of these systems continues to fall over time. Cost-effective dual processor systems, along with multiprocessor versions of the Linux and Windows operating systems, are also available.

PC graphics continue to be developed at an impressive rate with increasing processing speed and additional features previously only found in higher end Unix workstation configurations becoming available.

A current ADSL "sweet spot" configuration such as:

- 2.4 GHz Intel Pentium IV
- 1 GB RAM
- 60 GB Hard drive
- 1Gbps/100 Mbps ethernet card
- Multimedia Kit - CD-ROM, sound card speakers
- 128 MB 4x AGP GeForce 4 Ti4400 graphics
- 19 inch monitor
- Windows XP Professional

can be purchased for less than $A4500.

An "equivalent" proprietary RISC processor plus Unix operating system configuration would cost many times this price thus the use of such cost-effective, *"corner store"*, PC hardware is recommended.

2.2 Operating System Software

Acceptance of such a cost-effective PC hardware configuration reduces the operating system software of choice to Linux or Microsoft Windows. In the ADSL the "standard" operating system used is Microsoft Windows because:

- it is the *de facto* standard desktop computer operating system,
- programming staff are easily obtained,
- a re-learning process for a new operating system is not required,
- no legacy Unix applications need to be ported,
- it allows applications to be developed on one's office desktop computer, and
- more programming toolkits are available for Microsoft Windows than any other operating system.

It is recommended that Microsoft Windows be used as the operating system of choice.

2.3 CCT Application Programming Languages and Toolkits

DIS applications developed in the ADSL use both the Microsoft C++ and Visual Basic programming languages.

Until recently all DIS applications produced in the ADSL used the MäK Technologies [4] VR-Link toolkit. It is an excellent middleware product which allows both DIS and HLA applications to be produced with little change to the code, it provides many of the conversion routines required in DIS application software, and it is available as a development toolkit and as a more cost-effective, runtime license only version. It is possibly too expensive to distribute as part of a Common Coalition Toolset. An option here is the US Navy's Simulation Middleware Object Classes (SMOC) toolkit that appears to provide the same functionality as the VR-Link toolkit.

For a particular class of applications, a toolkit such as VR-Link is not necessary. However the programmer must then provide, or obtain elsewhere, the various conversion routines required. In the ADSL applications have been produced using both the Microsoft C++ and Visual Basic programming languages that have not required specialised toolkits such as VR-Link.

The C++ programming language gives programmers access to all facilities provided by the Microsoft Windows operating system. However some programmers prefer to use the Visual Basic programming language that can be used to produce Windows Graphical User Interface applications quickly and easily.

There are at least two ways to receive and send DIS UDP packets in Microsoft Windows applications. You can use the Winsock DLL or you can use the Microsoft Winsock ActiveX component. Using the DLL method is more flexible but not as convenient as using the ActiveX component method, especially if writing software in Visual Basic. The ActiveX component method restricts the flexibility of Winsocks - only one application per PC can use the one UDP port number. Also there appears to be an upper UDP packet size limit (i.e. a bug) and large UDP packets, such as a DIS Signal PDU containing voice data, are not transmitted. The single tasking nature of Visual Basic is also limiting.

Hopefully these limitations will be overcome in the new, re-architected, Microsoft Visual Studio.NET product. This new release of Visual Studio includes Microsoft's new programming language C#. C# will become Microsoft's flagship programming language and should also be considered when writing ADSL applications. Java and other third party languages or language products, such as Borland's C++ builder, should also be considered.

3. CCT Applications

Every Microsoft Windows based PC in the AOD ADSL runs the ADSL Management and Configuration (ManCon) application shown in Figure 1 below. Any computer on the ADSL network running the ManCon application can run any of the applications supported by ManCon. The functionality of the ADSL ManCon application has been described in detail in a previous publication [3]. The ManCon program demonstrates some of the functionality required in a Common Coalition Toolset.

3.1 A User Friendly CTT Application Loader

The bottom section of the ADSL ManCon application interface shows a User Friendly Graphical User Interface (GUI) CTT Application Loader.

In the ADSL the ManCon application runs on every PC on the network. The same interface is presented to the user and any application can be run from any PC on the network within application licensing restrictions. When the user left clicks the appropriate button from the GUI, ManCon runs an appropriate batch file to launch the required application.

Currently, to reduce application load time, all applications and their relevant data files are stored on every PC in the ADSL network. Whenever ManCon itself, or any ManCon loaded application, is modified the modified application must be copied to and updated on every PC on the network. In future, to reduce maintenance, all ADSL applications, including the ManCon application itself, and any corresponding data files will be stored and loaded from an ADSL application file server once the complete ADSL Local Area Network (LAN) is upgraded to 1Gbps networking.

Some ManCon loaded applications may need information, such as entity type, terrain location, DIS version number etc. to be loaded along with the application. For example when the Stealth program is required it must be loaded with the terrain location, the 3D terrain database, any entity 3D model files etc. to ensure that the Stealth application functions correctly. Where required such application parameters are entered via the ManCon application GUI.

The ManCon application is written in Microsoft Visual Basic version 6.

Figure 1: The ADSL ManCon Program.

3.2 An Entity Generator

To test an ADS network, an Entity Generator, which injects Entity State PDUs (ESPDUs) or HLA packets onto the ADS network, is required. Other ADS applications on the network can then be used to see if they can detect these generated ESPDUs.

In the ADSL the Visual Basic ManCon GUI Application Loader generates entities by executing the MäK Technologies VR-Link f18 utility program with the appropriate command line parameters (entity type and enumeration, longitude, latitude, circuit radius, speed, altitude, DIS version number etc.). For the CCT the f18 utility could/would be replaced by a functionally equivalent, royalty free, application produced using the USN SMOC toolkit. Additional command line parameters, such as a user input markings field, could also be added.

The Entity Generator application quickly and easily tests whether the computer the application is running on can successfully inject entities onto the ADSL network.

Currently the entities available in the Entity Generator are hard coded in the Visual Basic ADSL ManCon program. When this program is converted to Visual Basic.NET the available entities will be entered into the ManCon program via a configuration file. This configuration file can then be easily modified when required and when a coalition exercise, such as the I/ITSEC 2001 exercise, is held it will be much easier to email a configuration file to participants rather than emailing Visual Basic executables. In addition, this configuration file can also be used by other CCT applications such as a DIS PDU Filter application described in section 3.8.

3.3 Data Displaying Entity Detector Applications

In the ADSL two data displaying, entity detector applications are used.

3.3.1 MäK Technologies VR-Link Netdump utility

The MäK Technologies VR-Link Netdump utility is used (see Figure 2) to indicate that DIS PDUs or HLA packets are present on the network. It is a simple application to load and use and displays all PDU data from any version of DIS detected on the network. Netdump displays all the data available in the packets and is useful when there are only a few PDUs or HLA packets and/or when only one type of PDU or HLA packet is on the network.

When there are large numbers of PDUs or there are many different PDU types the Netdump utility becomes less useful as the data displayed is quickly overwritten. In this situation the ADSL DIS Analyser / Logger program is used.

3.3.2 The ADSL DIS Analyser / Logger Application

The ADSL DIS Analyser / Logger application has been written in-house specifically to assist in setting up and monitoring a DIS exercise. Data from different versions of DIS [5, 6, 7] and different PDU types [8] can be concurrently monitored and displayed. The main Graphical User Interface of the ADSL DIS Analyser / Logger application is shown in Figure 3.
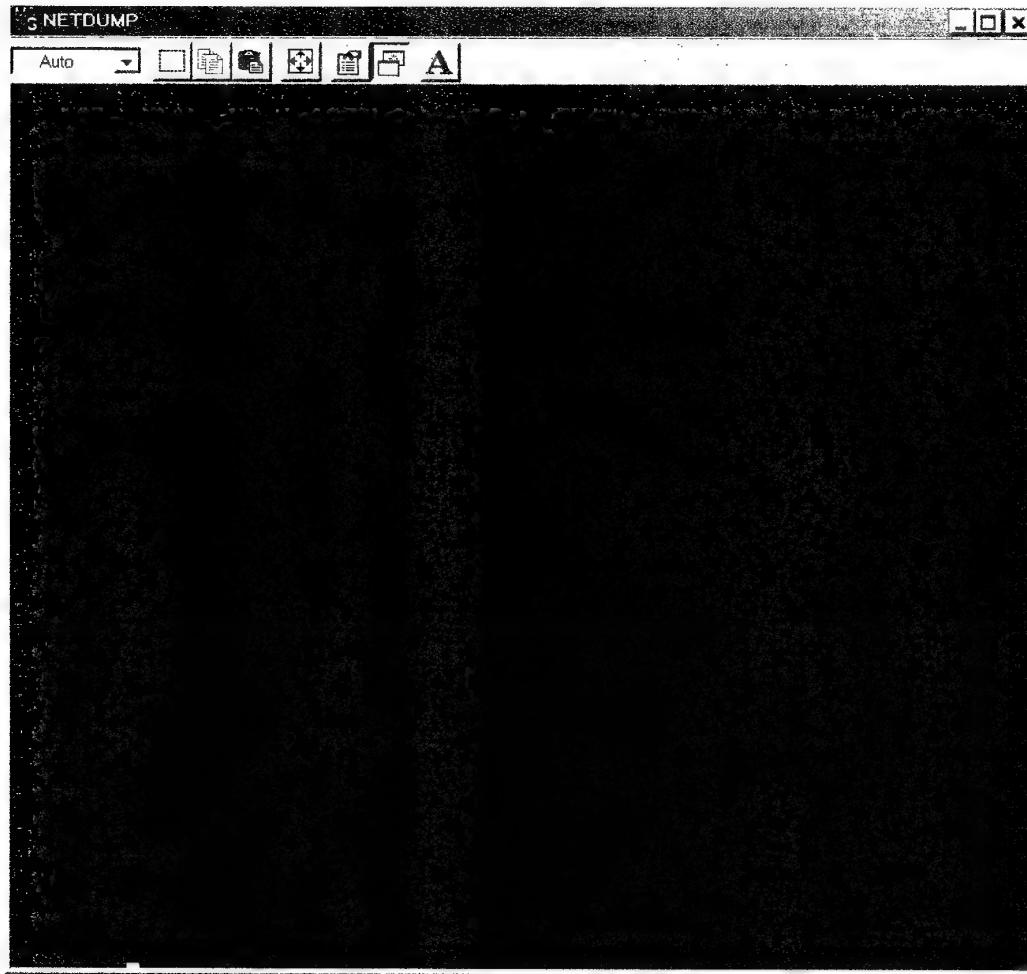

Figure 2: MäK Technologies VR-Link Netdump utility.

When setting up a DIS exercise, one of the first issues to be determined is what version of DIS [5, 6, 7] is to be used as unpredictable behaviour may occur if a simulator detects a PDU belonging to a version of DIS which is incompatible with the simulator (i.e. a newer version of DIS). The DIS Data Summary frame (top right hand corner of Figure

3) easily displays when different version DIS PDUs are detected. The offending simulators are also identified from the Site : Application : Entity ID data triplet also shown in the DIS Data Summary frame.

Figure 3: The ADSL DIS Analyser / Logger Program.

Other statistical and graphical data such as DIS PDU version numbers, how many PDUs of each type have been detected, Site : Application : Entity triplet information, DIS bandwidth estimates etc. are also displayed and monitored by the ADSL DIS Analyser / Logger application.

If a Site ID regime is enforced, Figure 4 shows how this (sorted) Site : Application ID data is displayed in the ADSL DIS Analyser / Logger application. Site, Site : Application, Site : Application : Entity ID : Entity, Entity : Site : Application : Entity ID, Entity Type, and Undefined PDUs can also be similarly sorted and displayed as shown in Figure 4. These data are automatically updated every 5 seconds.

DIS Network traffic (again automatically updated every 5 seconds) can also be displayed and is shown in Figure 5.
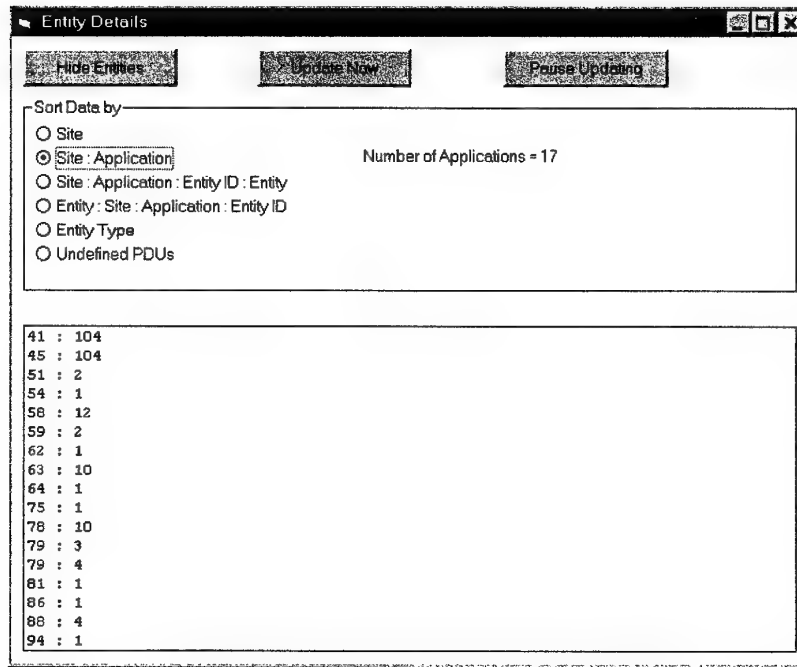
Figure 4: Sorted Site : Application ID data.

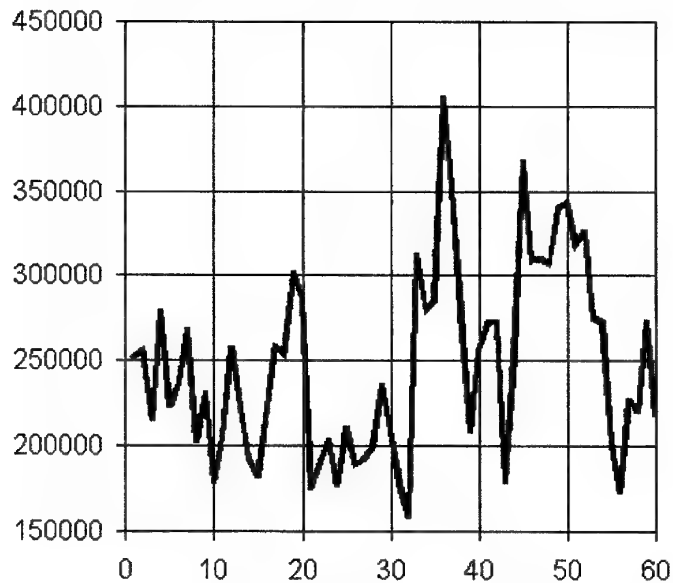**Network Traffic in bps Over Last 60 secs**

Figure 5: DIS Network Bandwidth (traffic) data.

At high DIS traffic rates (i.e. bandwidth) the main Graphical User Interface of the ADSL DIS Analyser / Logger application is not updated while the Entity Details and Network traffic forms shown in Figures 4 and 5 are being processed and updated. Also a particular periodic behaviour (with an approximate period of 5 seconds) is observed in the Network Traffic graphs. This appears to be a result of the fact that Microsoft's Visual Basic does not support prioritorised true multitasking. One possible way to reduce these effects is to run the ADSL DIS Analyser / Logger application on the fastest computer possible thus reducing the time required for the Entity Details and Network traffic forms to be processed and updated. The lack of these capabilities will, hopefully, be addressed in the new Visual Basic.NET compiler.

The ADSL DIS Analyser / Logger application has been used to help set up and monitor a DIS exercise where

- Several million PDUs were detected and analysed,
- DIS Network Traffic of at least 2.5 Mbps was analysed, and
- Up to 1500 PDUs per second were processed on a 1GHz Pentium III PC.

The ADSL DIS Analyser / Logger application can log and replay DIS data. However as already discussed in section 2.3 the application will not replay large (size) DIS Signal PDUs which carry DIS voice data.

Because the ADSL DIS Analyser / Logger is written in Visual Basic the executable can be distributed as a royalty free application however it does suffer from the limitations mentioned above and previously described in section 2.3 of this paper. Rewriting this application in Visual Basic.NET will, hopefully fix these limitations.

3.4 2D Map Display Applications

A 2D, DIS, Moving Map Display application has been developed by the author in Visual Basic for use in the ADSL. This application is shown in Figure 4. Using this application, the user can place the 2D Display viewing area at a particular location or the map can be centered onto a particular DIS entity. In the "Fixed Location" mode the scenario entities are displayed moving across a map that is fixed at a particular location. In the "Moving Map" mode the chosen entity icon remains fixed at the centre of the display window with the map moving under the selected entity icon.

The user can zoom in and out, various data (Identity, Site: Application: Entity DIS PDU data, speed, altitude etc.) can be displayed next to the entity icon and enitities can be filtered out according to their DIS domain (Land, Air or Surface). Because the software used to develop this application does not require any runtime licenses this application can be distributed royalty free. However because of the lack of software development resources the ADSL mainly uses the MäK Technologies Plan View Display (PVD) application, which has similar and additional functionality, but is a licensed, Commercial-Off-The-Shelf (COTS) product.
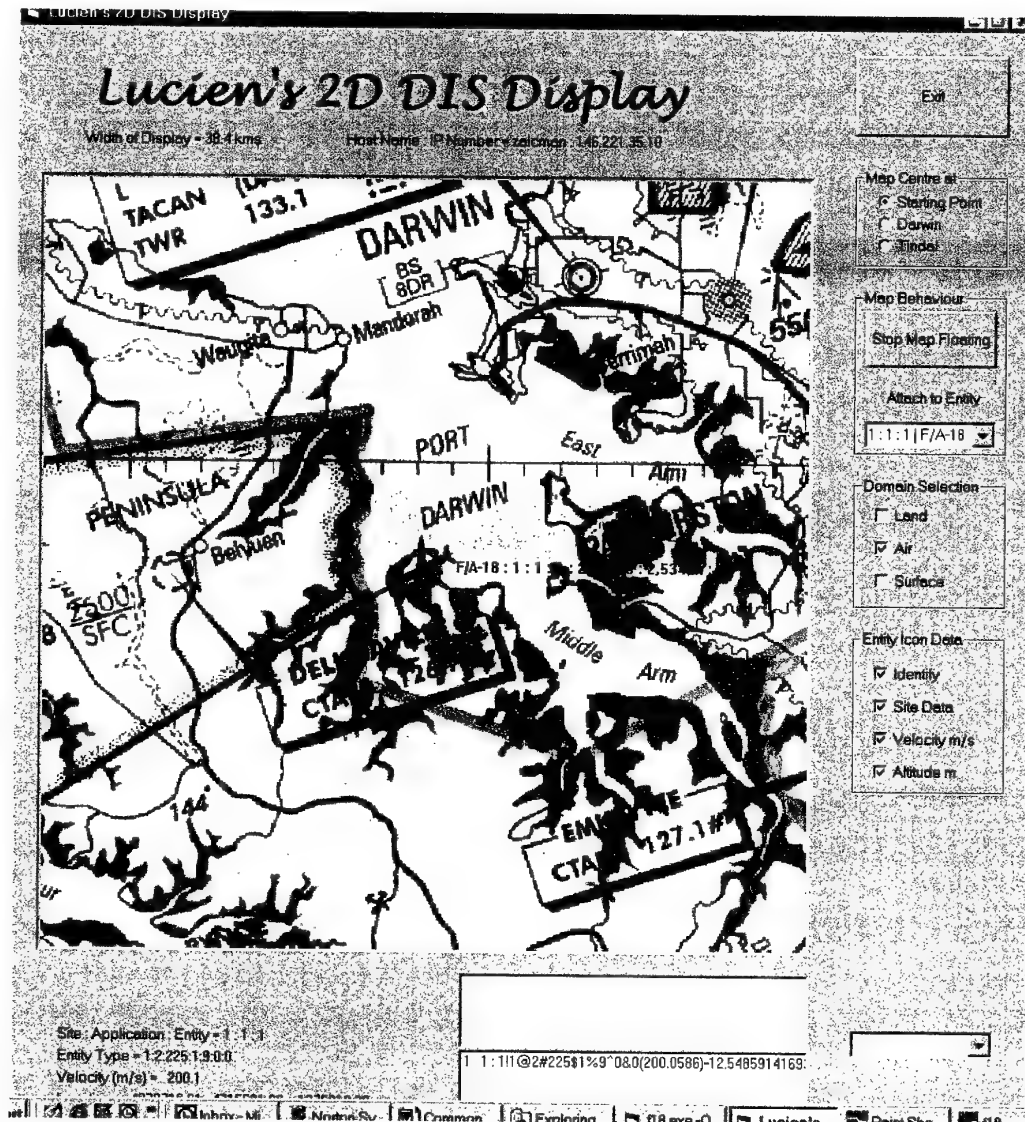
Figure 4: The ADSL 2D Moving Map Display Program

The Moving Map application has problems loading large map images whereas the PVD does not have such problems. The PVD product has already had a considerable development cycle and appears to be reasonably error free. Figure 5 shows the PVD displaying entity data that was recorded during the joint I/ITSEC 2001 demonstration / exercise between the US Navy and the Australian Navy.

The advantages in using (a COTS product such as) the PVD are:
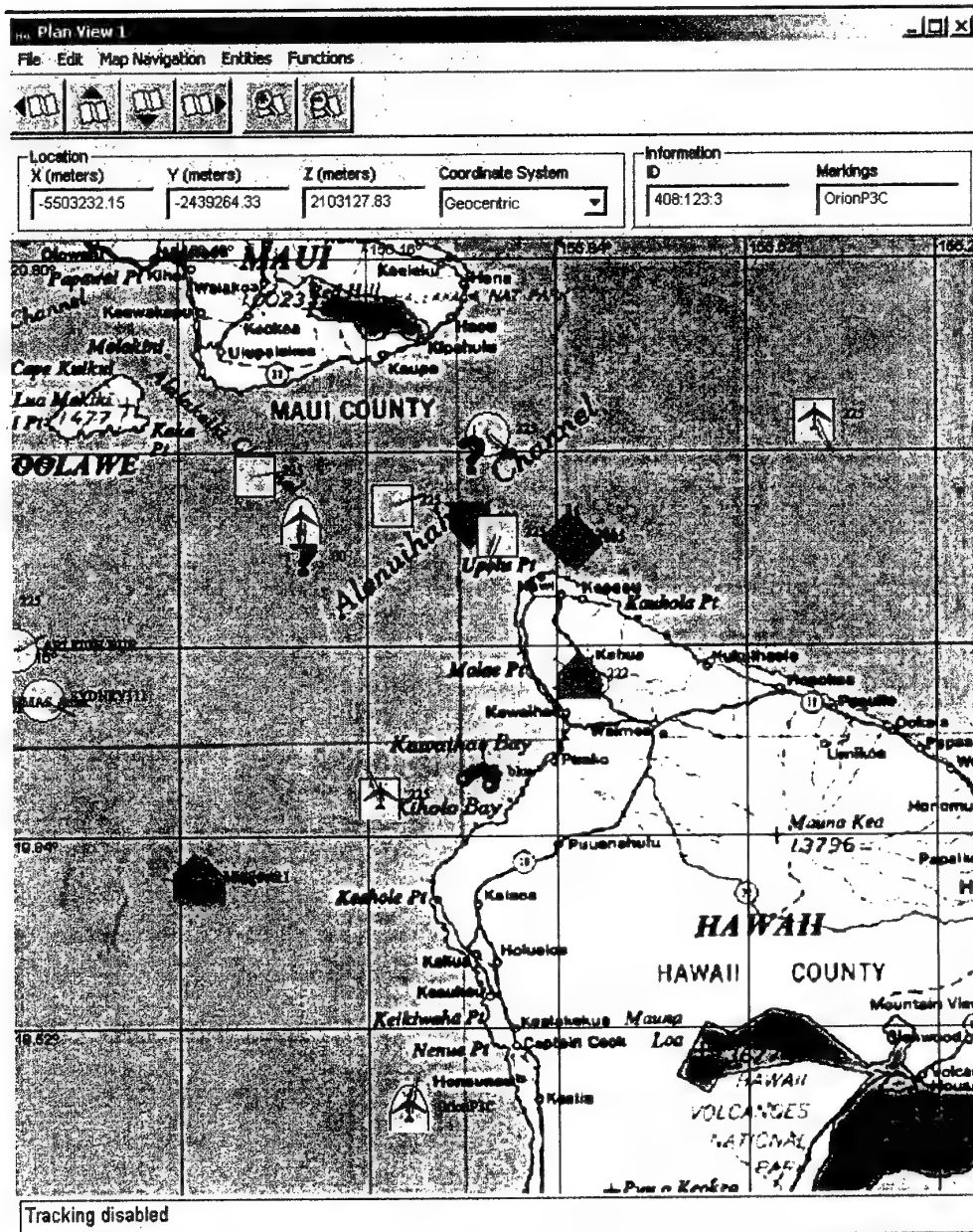
Figure 5: MäK Technologies Plan View Display.

- The PVD code is reused as the Front-end Client part of MäK Technologies VR-Forces Computer Generated Forces (CGF) product therefore any user modifications made to the PVD can also be used in the client front-end of VR-Forces;
- The PVD has an "integrated coupling mode" to allow it to take control of a MäK Technologies PC Stealth application on the network;

- There is considerable product infrastructure already available in the PVD product; and
- Because the PVD is a COTS product good support should be available.

3.5 A Data Logger Application

The ADSL DIS Analyser / Logger program can log and replay data. Unfortunately the program does not replay DIS Signal PDUs back onto the ADSL local area network although the data is displayed in the Signal PDU Specific Data area in the DIS Analyser / Logger GUI shown in Figure 3. This indicates that the Signal PDU data is being detected and stored correctly within the DIS Analyser / Logger program but is not being sent out onto the ADSL local area network in a DIS UDP packet.

All other DIS PDUs appear to be correctly broadcast onto the ADSL local area network as these PDUs are observed and interoperate with other applications as expected. The Signal PDU, which contains the digitised DIS radio audio information, is considerably larger in size than the other PDUs with the ASTi DIS Radio Signal PDUs being 8192 bits in length – not counting any Ethernet packet wrapping information. This infers that there is a UDP large packet size problem (bug) in the Microsoft Winsock ActiveX component used with the Microsoft Visual Basic Pro toolkit.

Because of this UDP packet size problem, the ADSL generally uses the MäK Technologies Data Logger application. This application does not appear to have any problems whatsoever and simply records and plays back all PDUs detected on the network.

Although MäK Logger is currently satisfactory, the ADSL will require an "Event Driven" Logger (Replayer) application in the future. Although the MaK Logger API can support "Filter" and "Replay from Time" capabilities a GUI to provide these capabilities must be coded by the user. DIS / HLA Event Driven Logger / Replay applications with user friendly GUIs already exist and the ADSL will need to consider purchasing such a COTS product in the near future.

3.6 A 3D Stealth Application

The ADSL uses MäK Technologies PC Stealth as its 3D Viewer application. This 3D Viewer application allows the observer's viewpoint to be placed anywhere in the exercise virtual world at either a particular location or connected to a participating entity in a particular viewing mode.

Figure 6 shows the 3D Viewer attached to HMAS SYDNEY participating in the I/ITSEC 2001 exercise. The Stealth's viewpoint is slowly rotating around HMAS SYDNEY (in an orbit mode). The virtual world location, shown in the bottom right hand corner of Figure 6, is South-West of the Alenuihaha Channel between the

Hawaiian Islands of Maui and Hawaii. The location of the HMAS SYDNEY in this exercise in a 2D Map Display can be seen, at a similar virtual world location, at the middle of the left hand side of Figure 5.

Figure 6: 3D View of HMAS SYDNEY in the I/ITSEC 2001 demonstration.

3.7 Common Terrain and 3D Model Databases

The ADSL is building up its terrain and 3D model generation capabilities. During the I/ITSEC training exercise a Hawaiian Islands terrain database was built up using the Terravista Pro terrain generation software package. The Multigen Creator software application was used to generate 3D models required.

A considerable amount of resources (data, skill and time) are required to produce terrain and 3D model databases. These databases are used by the 2D and 3D viewer applications shown in Figures 5 and 6. Whenever an exercise is carried out these terrain and 3D model databases should be provided, and retained for future use, as part of a CCT release to be used for that particular exercise. Not having every participant producing their version of the same terrain and 3D model databases will save a considerable amount of effort.

3.8 After Action Review Tool

In an After Action Review (AAR), training participants, sometimes assisted by a facilitator, come together at the conclusion of the exercise to examine the results of the training event to determine what happened, why did it happen, and how to improve performance [9]. Because DIS Protocol Data Units (PDUs) carry information relating to entities (i.e. "what happened?") Distributed Simulation offers the opportunity to use COTS DIS applications to create a team orientated AAR tool suite.

Such an AAR tool suite could comprise a tightly integrated event driven data logger, a 2D Plan View Display (PVD) and a 3D Out-The-Window Stealth viewer [10]. A DIS voice / radio communications capability could, if required, also be included in such a tool suite. In such a system, not only should the logger record and replay (DIS) data, but the data should be organised and well presented to easily enable key aspects (i.e. events) of performance to be examined (i.e. "why and when did it happen?"). This must be done as soon as possible after the end of the exercise to enable rapid debriefing and detailed timely feedback on individual and collective performance and their relation to combat outcomes (i.e. "how to improve performance?").

The combination of the MäK Technologies Data Logger, 2D Plan View Display and 3D Stealth applications provides a basic ADSL demonstration AAR debrief tool. However the current version of the Data Logger does not present any event driven aspects to the user and there is little integration between the 2D Plan View Display and the 3D Stealth applications.

3.9 DIS PDU Filter Application

In an Advanced Distributed Simulation (ADS) exercise, participating simulators may have varying levels of capability. Older simulators (eg military training simulators which may take many years to complete their acquisition cycles) may not have sufficient processing power to participate in large, complex exercises that may generate high numbers of PDUs (eg several thousand PDUs per second) on the simulation network. Also some simulators may respond unpredictably to incoming, unrecognisable data packets.

A simple DIS PDU Filter application would only allow selected PDUs to pass from the simulation network to the relevant simulator thus reducing the probability of failure, in the first instance, of that simulator. This DIS PDU Filter application could, at load time, initialise using the same configuration file used by the Entity Generator previously mentioned in section 3.2.

3.10 DIS PDU Version Number Converter

During the set up and running of the I/ITSEC 2001 exercise some DIS PDU incompatibilities were detected. Interrogate Friend or Foe (IFF) PDUs from the USN Battle Force Tactical Training (BFTT) systems were detected as DIS Protocol Version 5 (1278.1 – 1995) PDUs [11]. BFTT also has (slightly different) Protocol Version 6 (1278.1A – 1998) IFF PDUs [11]. According to the IEEE 1278.1A Standard [7] the IFF PDU only exists as a Protocol Version 6 PDU.

If an IEEE compliant application detects an incompatible BFTT, Protocol Version 5, IFF PDU unpredictable behaviour could result. In such a *"mixed"* network the backbone Wide Area/ Local Area (WAN/LAN) DIS exercise network should standardise on a particular standard, eg. IEEE 1278.1A. A DIS PDU Version Number Converter application would then make all the necessary PDU conversions to remove (where possible) any incompatibilities between the particular simulator standard (eg BFTT) and the backbone WAN/LAN standard (eg. 1278.1A).

If a DIS PDU Version Number Converter application detected such a Protocol Version 5, IFF PDU from a particular simulator it would a) change the Protocol Version number from 5 to 6, b) reconstruct the PDU to include the additional data fields present in the IEEE 1278.1A IFF PDU, where possible filling the additional data fields with valid data, and d) transmit the converted, IEEE 1278.1A, Protocol Version 6, IFF PDU onto the WAN/LAN backbone network. The BFTT, Protocol Version 5, IFF PDU would not be transmitted onto the WAN/LAN backbone network. Similarly if an IEEE 1278.1A, Protocol Version 6, IFF PDU were detected on the WAN/LAN backbone network the reverse would also have to occur.

Because legacy military training simulators have such a long acquisition life cycle they may not support the latest IEEE 1278.1A version of DIS. This DIS PDU Version Number Converter application could be used by legacy training simulators to convert their DIS interfaces to a common DIS standard. Also the DIS PDU Version Number Converter application and the DIS PDU Filter application could be combined into a single application.

3.11 DIS / HLA Gateway

Whereas modern simulators may have the capability to interoperate using HLA, most existing legacy simulators (and those still part way through their acquisition cycle) are more likely to use DIS protocols to interoperate. In the near future there will be a continuing, and growing, requirement to provide interoperability between DIS and HLA simulators participating in the same exercise.

Specifying a particular IEEE DIS standard (eg IEEE 1278.1A) fixes what PDUs can be supported and the format and values of data fields in these supported DIS PDUs. The HLA "methodology" requires that the format and values of the HLA data fields are

hidden from the user and are defined through the Federation Object Model (FOM). To correctly interoperate with a particular DIS/HLA Gateway using HLA a simulator must have a Simulator Object Model (SOM) that is compatible with the particular DIS/HLA Gateway FOM.

No modification of the existing, legacy DIS simulator is required because the Gateway application executes on a stand-alone PC. On the DIS side of the Gateway, PDUs are formatted, sent, and received accordingly. The Gateway receives these packets and translates them at two levels: (1) the DIS PDUs are converted into the data formats defined in the Gateway FOM, and (2) the sequence of packets are translated into corresponding RTI service invocations.

The Gateway performs a similar conversion for data received from the HLA federation execution. The Gateway must also perform those functions for which there are no DIS analogues. These functions include creating, destroying, joining, and resigning federations and publishing and subscribing to the required FOM classes.

Thus a CCT DIS/HLA Gateway must support a commonly used and/or specifically designed (generic) FOM. The Real-time Platform Reference FOM [12] (RPR-FOM) and the USN Naval Training Meta-FOM [13, 14] (NTMF) are examples of FOMs designed with this objective in mind. The Real-time Platform Reference (RPR) FOM is a HLA description of the DIS application protocols. The RPR-FOM will eventually support the full functionality contained in IEEE 1278.1A - the final version of DIS. It is now a Simulation Interoperability Standards Organisation (SISO) standard [15].

4. Summary and Conclusions

- A (starting) set of Advanced Distributed Simulation applications has been proposed to make up the Common Coalition Toolset (CCT).
- These CCT applications can be used to establish, maintain and analyse connectivity and interoperability for coalition training demonstrations and/or exercises.
- Having such a Common Coalition Toolset of applications, which all participating nations will have access to, allows such demonstrations and/or exercises to be more effectively and efficiently set up and maintained.
- The starting set of applications that has been proposed and discussed is currently used in the DSTO Advanced Distributed Simulation Laboratory.
- Some of these applications were used during a coalition training exercise carried out as a special event at the I/ITSEC 2001 Conference between 1) RAN simulators located at HMAS Watson in Sydney, Australia, 2) USN PMS430 simulators located at Orlando, Florida and Dam Neck, Virginia in the USA and 3) TNO Simulators located in the Netherlands.
- A combination of COTS and self-written, royalty free applications used in the DSTO ADSL have been discussed.

- In addition to the proposed CCT applications, operating systems, programming languages and distributed simulation toolkits have been discussed and recommended.
- These operating systems, programming languages, distributed simulation toolkits and CCT applications discussed and recommended are not meant to be a definitive toolset. The objective of this paper is to start the discussion of the concept of a Common Coalition Toolset.

5. References

1. Battle Force Tactical Training web site: http://www.pms430.com/

2. Zalcman, L. and Ryan, P. (2000). Low Cost Testbed for Advanced Distributed Simulation, *Proceedings of SimTecT 2000*, 28 February-2 March 2000, Sydney, Australia, pp 337–342

3. Zalcman, L. (2001). Experiences with a Network of Cost-Effective, Advanced Distributed Simulation Computers, *Proceedings of SimTecT 2001*, 28-31 May 2001, Canberra, Australia, pp 191–198

4. MäK Technologies web site: http://www.mak.com/

5. IEEE 1278-1993 (1993). *IEEE Standard for Information Technology - Protocols for Distributed Interactive Simulation Applications.*

6. IEEE 1278.1-1995 (1995). *IEEE Standard for Information Technology - Protocols for Distributed Interactive Simulation Applications.*

7. IEEE 1278.1a-1998 (1998). *IEEE Standard for Information Technology - Protocols for Distributed Interactive Simulation Applications* (available from http://www.ieee.org/)

8. Pitch web site: *"DIS – an early simulation interoperability standard"*: http://www.pitch.se/fmv/default.htm

9. http://www.ari.army.mil/pdf/AAR-Tools.pdf/

10. McGaughey, S. (2001). Battle Force Tactical training After Action Review, *Proceedings of the Interservice/Industry, Simulation and Education Conference*, Orlando, USA, November, 2001.

11. Interface Requirements Specification / Interface Design Document for Battle Force Tactical Training (BFTT) System – T8901-XX-IRS/IDD-010/BFTT System, 6 September, 2000

12. Shanks, G.C. (1997). "The RPR-FOM. A Reference Federation Object Model to Promote Simulation Interoperability", 97S-SIW-135, *1997 Spring Simulation Interoperability Workshop.*

13. Bergenthal, J.J, Clark, D, Maassel, P.W., and C. Root, (1999). "Development of a Naval Training Federation", 99F-SIW-054, *1999 Fall Simulation Interoperability Workshop*, Orlando Florida

14. Ryan, P., Clark, P., Zalcman, L., Colton, T., Kassal, P., and Clark, D., (2002). "Australian / US Collaborative Development of Joint Meta-FOM for Coalition Training in Synthetic Environments", *Proceedings of SimTecT 2002*, 13 – 16 May, 2002, Melbourne, Australia (to be published).

15. http://www.sisostds.org/stdsdev/rpr-fom/index.htm

6. Glossary of Acronyms

ADF	Australian Defence Force
ADO	Australian Defence Organisation
ADS	Advanced Distributed Simulation
ADSO	Australian Defence Simulation Office
AOD	Air Operations Division
AOSC	Air Operations Simulation Centre
API	Application Programmer's Interface
AUT	Application Under Test
BFTT	Battle Force Tactical Trainer
C^{3}I	Command, Control, Communications, and Intelligence
CGF	Computer Generated Forces
COTS	Commercial-Off-The-Shelf
DDG	Guided Missile Destroyer
DIS	Distributed Interactive Simulation
DIU	DIS Interface Unit
DMSO	Defense Modeling and Simulation Office (US)
DoD	US Department of Defense
DSTO	Defence Science & Technology Organisation
DTS	DIS Test Suite
FEDEP	Federation Development and Execution Plan
FFG	Guided Missile Frigate
FOM	Federation Object Model
HiL	Human-in-the-Loop
HLA	High Level Architecture
HQADF	Headquarters, Australian Defence Force
IEEE	Institute of Electrical and Electronic Engineers
ISDN	Integrated Services Digital Network
IST	Institute of Simulation and Training (US)
ITEC	International Training and Education Conference
JOANNE	Joint Air Navy Networking Environment
LAN	Local Area Network
M&S	Modelling and Simulation
ModSAF	Modular Semi Automated Forces
MWTC	Maritime Warfare Training Centre
OBTS	On Board Training Systems
OMT	Object Model Template
PDU	Protocol Data Unit
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RPR-FOM	Real time Platform Reference FOM
RTI	Run Time Infrastructure
SISO	Simulation Interoperability Standards Organisation
STRICOM	Simulation Training and Instrumentation COMmand (US Army)

USN	United States Navy
VAE	Virtual Air Environment
VRML	Virtual Reality Modeling Language
VV&A	Verification, Validation and Accreditation
WAN	Wide Area Network

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Peter Kassal, US Naval Sea Systems Command, PMS-430, 1333 Isaac Hull Avenue SE, Washington Navy Yard, DC 20376, USA

US Navy Contractors

Jim Brewer, NOVONICS Corporation, 2001 Jefferson Davis Hwy, Suite 1105, Arlington, VA 22202, USA

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Systems Sciences Laboratory
PO Box 1500
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19. ABSTRACT

The recent I/ITSEC 2001 Coalition Training Demonstration held between the US, Australian and Dutch Navies demonstrated a valid coalition training exercise using Advanced Distributed Simulation to simultaneously connect military training simulators in the USA, Australia and the Netherlands. Whilst participating in the setting up and running of this exercise each participating nation used whatever tools were available to establish and maintain connectivity and interoperability. As one of the lessons learned from such a coalition exercise, this paper discusses a proposal to make available to all participating coalition nations a Common Coalition Toolset (CCT) which comprises a set of software applications used to establish and maintain connectivity and interoperability for such coalition training demonstrations and/or exercises. This paper describes some of the software applications making up this Common Coalition Toolset and what operating systems / programming toolkits etc. should be considered when creating such Common Coalition Toolset applications.

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